Chapter 18. Appendix 3. Data archives

Appendix for Chapter 3. Queensland fish board data

General Information

Fishing has occurred for a long time in Queensland, being used for subsistence by indigeneous and early European inhabitants. The first fishery to be developed after colonisation was the inshore fishery. The annual reports by harbours, which date back to the late 1800s comment that 'commercial fishermen disposed of their catch at the nearest population centres'. 'Fish caught in Moreton Bay about 1891 by the regular fishermen were brought up the Brisbane River to Breakfast Creek, fishermen from vessels working out of the Noosa River sent their fish to Gympie and Maryborough fishermen sent theirs to Gympie and Maryborough for distribution to the surrounding district. Some of the Morton Bay fisherman forwarded their catch by train to the Brisbane Markets from such convenient places as Sandgate, Pinkenba, Wynnum, Nambour, Stapylton, Coomera and Southport.' The Inspector of Fisheries James H. Stevens advocated the starting of a central fish market for Brisbane in 1901 as a means of controlling the size of fish being marketed. Regulations in force in 1902 had substituted 'length' for controlling fish size instead of 'weight'. Stevens advocated that all fish hawkers should be licensed for food safety reasons and to assist in the control of selling fish only caught by legal means. The Fisheries Act of 1904 provided for the marketing of fish and by 1907 the Brisbane Fish Market began operating.

Documentation of the scale and extent of fishing in Queensland is somewhat patchy. The main source of fishery catch data between 1930 and 1980 are the figures published in the annual reports of the fish board responsible for marketing and distributing fish in Queensland during this period. It is uncertain what proportion of the total Queensland fisheries landings these figures represent. Fisheries landings destined for interstate or international export were not required to pass through the fish board. Anecdotal reports suggest that a number of private companies handled fisheries landings independent of the fish board. However, there is some evidence to suggest that private handling of fisheries landings increased as the processing and marketing industry expanded with the introduction and growth the prawn trawlingindustry. There are numerous reports of black market sales of fisheries landings throughout Queensland, the timing and scale of which is difficult to quantify. Comparisons of Queensland Fish Board landings of with that reported by the Australian Bureau of Census & Statistics sheds little light on the proportion of total Queensland fisheries landings passing through the Queensland Fish Board, as the figures are very similar. This is not surprising as the Commonwealth Bureau of Census & Statistics derived fisheries statistics mainly from annual returns supplied by State fisheries authorities.

No effort data is available to compliment the landings data. From 1954 onwards, the trawling industry of the Queensland east coast and Gulf of Carpentaria was rapidly expanding. Anecdotal reports suggest that many individuals who previously net fished were drawn to the expanding trawl industry, resulting in unknown changes to fishing effort within net fisheries. The above factors impose limitations that should be considered in any analysis and interpretation of the Queensland Fish Board database (held in full electronic form by the Department of Primary Industries & Fisheries).

The Queensland Fish Board reports record 61 market 'categories'. These market categories have been assigned into the most likely current species or species group. It is difficult to confirm exactly which species comprised some of the market categories, but the interpretation has been checked against available Commonwealth and State reports that mention species names, as well as discussion with fishers and DPI&F staff. The species reported in the Queensland Fish Board Landings are listed in Table A.3.1.

Table A.3.1 Species occurring in the Queensland Fish Board landings data

Current CFISH name	QFB name	Other names	Scientific name
Barramundi	Barramundi	Giant Perch	*Lates calcarifer*
Blue swimmer crab	Crabs, sand, meat		*Portunus pelagicus*
Blue swimmer crab	Crabs, sand, bodies		*Portunus pelagicus*
Blue threadfin	Salmon	Cooktown salmon	*Eleutheronema tetradactylum*
Bream, mixed	Bream black	Pikey bream	*Acanthopagrus berda*
Bream, mixed	Bream		*Acanthopagrus australis*
Butterfish	Johnny dory	dory, john dory, old maid, scat	*Scatophagus multifasciatus*
Cod	Cod		*Epinephelus spp.*
Coral trout	Coral trout		*Plectropomus spp.*
Dart	Dart		*Trachinotus spp.*
Flathead, mixed	Flathead		*Platycephalus arenarius, inducus,*
Gar	Gar		*Hyporhamphus spp.; Arrhamphus sp.*
Grunter bream	Trumpeter	Javelin fish	*Pomadasys* sp.
Jew	Jew		
King threadfin	Salmon Burnett	Threadfin salmon	*Polydactylus sheridani*
King threadfin	King	Threadfin salmon, Burnett Salmon	*Polydactylus sheridani*
Leatherjacket	Leather jackets	Monacanthidae	
Lethrinid	Emperor		*Lethrinius spp.*
Lethrinid	Sweet lip		*Lethrinius spp.*
Longtom	Long toms	Needlefish	*Tylosurus spp.*
Mackerel, mixed	Mackerel		*Scomberomorus* sp.
Mackerel, mixed	Mackerel school		*Scomberomorus queenslandicus*
Mixed fish	Mixed		
Mud crab	Crabs, mud, meat		*Scylla serrata*
Mud crab	Crabs, mud, bodies		*Scylla serrata*
Mullet	Mullet		*Mugil cephalus, Liza* sp.
Oysters	Oysters, bottles		
Oysters	Oysters, bags		
Parrot	Parrot	Scarids	
Pearl perch	Pearl perch		*Glaucosma scapulare*
Prawns	Prawns mixed		*Penaeus* sp., *Metapenaeus* sp.
Ray	Ray		*Penaeus* sp., *Metapenaeus* sp.
Samson	Sampson	Amberjack, pool with Yellowtail	*Seriola hippos*
Sea perch	Nanygai	Saddletail, Fingermark	*Lutjanus spp.*
Sea pike	Pike	Barracuda	*Sphyraena spp.*
Sea pike	Barracouta	Barracuda	*Sphyraena spp.*
Shark	Shark		Carcharhinidae
Snapper	Squire		*Pagrus auratus*
Snapper	Snapper	Red bream	*Pagrus auratus*
Spanner crab	Crabs, spanners, bodies		*Ranina ranina*
Squid	Squid		
Sweetlip bream	Morwong	Haemulidae	*Diagramma* sp, *Plectorhinchus* sp
Tailor	Tailer		*Pomatomus saltatrix*
Whiting mixed	Whiting		*Sillago* sp.
Yellowtail kingfish	Yellow tail	Yellowtail Kingfish	*Seriola lalandi*

Monthly fisheries landings that passed through the Brisbane Fish Market from 1936 to 1945 are recorded by the annual reports, but do not indicate the point of origin of the landings. More location specific information is available from 1945, where the annual financial year landings from each depot are reported. Fisheries landings were recorded from 46 districts (=depots). The depot landings do not guarantee that landed fish was sourced from a particular area. For the purposes of analyses, we assume that the majority of the fish landed at a depot were caught in the nearby area.

Fisheries landings were recorded in pounds (lbs) until 1973/1974, and then in kilograms (kg) for most market species. All landings data were converted to kg. An additional conversion was required to convert fish fillets to an equivalent gilled and gutted weight (2 x fillet weight), sand crabs and spanner crab bodies (i.e. numbers) to kg (3 crabs per kg) and mud crab bodies (i.e.

numbers) to kg (1 crab per kg). Landings or crab meat, mud crab meat and sand crab meat were converted to a whole green weight using the following meat recovery rates: crab meat (unspecified) 30%, mud crabs 25% and sand crabs 35%. Dr Ian Brown supplied meat recovery figures from research work.

Barramundi

Barramundi is the consistent marketing name for *Lates calcarifer*. Few references are made to barramundi in the Queensland Fish Board annual reports. Dunstan (1959), in his review of barramundi in Queensland waters remarks that 'a large part of the barramundi catch in eastern Australia is made by part-time fishermen who generally do not market through the fish board'. However, he also states that 'the total weight of fish marketed (by the fish board) represents only part of the total catch, but it is a constantly related part and the figures can thus be used as an accurate indication of overall yearly trends'. We suspect that the barramundi of the Fitzroy and Port Curtis region have a large degree of interchange (via the Narrows) and that much of the barramundi landed in Gladstone could have been caught at the mouth of the Fitzroy or in the Narrows. While currently considered separately, evidence is building that barramundi landings currently allocated to Fitzroy and Port Curtis should be pooled into a 'greater Fitzroy'.

Mullet

Mullet is the consistent marketing name of a number of species, including *Mugil cephalus*. Mullet was a major component of the inshore net fisheries, suppling the local fish and chip trade with fish fillets. Mullet landings were often in excess of demand, leading to over-supply. To provide a means of return on glut quantities, the Queensland Fish Board bought excess landings and these were then sold to Government institutions (e.g. several hospitals, Peel Island Lazeret, and Brisbane Goal). An example of the scale of government purchase of mullet can be seen in 1936/1937, where a reported 2½ tons of sea mullet per week was supplied during the mullet season. This arrangement ceased in the mid 1970s. Mullet landings suffered from 'kerosene taint' in which fish affected by the taint could not be sold. This problem caused a change in fishing practices e.g. fishos normally taking fish from north of the Brisbane River estuary during the months of May and June were active elsewhere. Kerosene taint is likely to have changed landings for the Moreton Bay region, but its impact on mullet landings in the Fitzroy and Port Curtis regions is unknown. Export of mullet is first reported upon in the 1959/1960 report. The Queensland Fish Board mullet landings data are not the best representation of annual mullet landings because financial year is half way through the winter season fishery for sea mullet.

Blue threadfin

Blue threadfin is the current marketing name for *Eleutheronema tetradactylum* previously known as 'Cooktown salmon', 'Blue salmon' and 'salmon'. In all annual reports of the Queensland Fish Board, there are the categories 'salmon' and 'king', and on occasion, an additional category of 'salmon Burnett'. This lead to the interpretation of the QFB annual reports that 'salmon' referred to blue threadfin and 'king' or 'salmon Burnett' referred to king threadfin (*Polydactylus macrochir*). This validity of this assumption is unknown, and as such, the use of blue threadfin and king threadfin versus threadfin combined should be used with caution.

King threadfin

King threadfin is the current marketing name for *Polydactylus macrochir (=sheridani*) previously known as 'Burnett salmon' and 'king salmon'. The term 'salmon, Burnett' appears in the annual reports from 1945/19460 to 1949/1950, but thereafter only the categories 'salmon' and 'king' appear. The current interpretation of threadfin landings in the annual reports of the Queensland Fish Board is that 'salmon' referred to blue threadfin and 'king' or 'salmon Burnett' referred to king threadfin. This validity of this assumption is unknown, and as such, the use of data for blue threadfin and king threadfin versus threadfin combined should be used with caution.

Mud crabs

Hill (1982) reports that the Queensland landings data for mud crabs are unreliable, mostly because of the possibility of mud crabs being shipped directly to interstate markets. For example, crabs caught in Princess Charlotte Bay (about 20,000 per year) were not handled by any fish board. In 1980, the Sydney Fish Market handled more crabs than the Queensland Fish Board, despite the small size of the NSW mud crab fishery. However, Hill (1982) suggests that the Queensland Fish Board data give a relative index of the production of various areas.

Whiting

This market category is a combination of several species of estuarine whiting. It is unknown whether whiting were a target species in the Port Curtis and Fitzroy regions or if they were incidental catch to other estuarine netting operations (e.g. fish traps).

Appendix for Chapter 6. Year class strength of estuarine fish

Marginal Increment Analysis

We counted the opaque increments, and assigned the marginal increment to one of three categories: (i) 'new', when the opaque increment was on the margin; (ii) 'plus', when the opaque increment was separated from the margin by a narrow translucent increment; and (iii) 'due', when the distance from the outer opaque increment to the margin was almost equal to the width of the previous translucent increment.

There was very clear differentiation between fast and slow growth zones on barramundi otoliths from the Fitzroy River estuary, as found by Stuart and McKillup (2002). Opaque (light, narrow) increments were visible on the margin of most otoliths collected in October, but were rarely on the margin of otoliths collected in February (Table A.6.1) suggesting that increments form by October. Therefore, when estimating the age of a fish collected in October, and when an increment was not visible on or near the margin of the otolith, we assumed that one should have been present. Consequently, an extra year was added to the estimated ages of 46 fish that were caught in October but had an otolith increment classed as 'due'.

Table A.6.1 Results of marginal increment assessment for barramundi in the Fitzroy River region. Marginal increments defined as: 'new', when the opaque increment is on the margin; 'plus', when the opaque increment was separated from the margin by a narrow translucent increment; and 'due', when the distance from the outer opaque increment to the margin was almost equal to the width of the previous translucent increment.

		Marginal Increment			
	Sample Time	New	Plus	Due	Total
Year–1					
	October 2000	154			154
	February 2001	2	412		414
Year–2					
	October 2001	85		44	129
	February 2002	1	192	3	196
Year–3					
	October 2002	122		2	124
	February 2003		319		319

Counts of opaque increments were converted to ages, taking into account the assessment of marginal increment and the date of capture. We assigned 1 January as the birthday of each fish, as the spawning season for barramundi extends from approximately October to March on the east coast of Queensland (Russell 1990). Therefore, all fish born during the same spawning season were assigned the same birthday and identified as belonging to the same year-class. Once ages were estimated, age-length keys were constructed and used to convert length-frequencies into age-frequencies. Age-length keys and length-frequency distributions were constructed for each of sampling trips and a single age-structure was constructed for each spawning season sampled (October plus February).

Year-classes recruited to the fishery

Barramundi has minimum (580 mm) and maximum (1200 mm) legal size-limits on the east coast of Queensland. Therefore, the size-structure of the commercial catch is not representative of the whole population. To account for this potential bias, we restricted analyses to a range of age-classes that were likely to be least biased by the restricted size-structure. We selected age-classes for inclusion in analyses after we examined the size-distribution of each age-class, in both October and February samples (pooled for all years). The youngest age-class we included was the youngest one for which >90% of the individuals measured were larger than the minimum size-class of fish sampled (580–599 mm). This criterion was used as an approximate indication that most fish in this age-class were likely to have reached the minimum legal size-limit. Likewise, the oldest age-class we included in our analyses was the oldest one for which >90% of the individuals we measured were smaller than the maximum size-class of fish sampled (1180–1200 mm). This criterion was used as an approximate indication that most fish in this age-class were unlikely to have exceeded the maximum legal size-limit.

The size and age structure of sample fish were examined to determine which age-classes to include in the analysis. At the lower end of the size and age ranges, 92.5% of two year-old fish were larger than the smallest size-class (580–599 mm, with 580 mm being the minimum legal size), but only three of these were caught during October trips. Therefore, we believed this age-class had not recruited sufficiently to the commercial fishery. Of the three year-old fish, 96.1% were larger than the 580–599 mm size-class, and three year-olds were common in October and February trips, so we decided this age-class was the youngest one that should be included in our analyses. At the upper end of the size and age ranges, the youngest fish to have reached the maximum legal size-limit was 10 years-old, although most 10 year-old fish were smaller than 1090 mm. Similarly, most 11 year-old fish were smaller than 1080 mm, with 93.3% being smaller than the largest 20 mm size-class (1180–1200 mm). While most 12 year-old fish were smaller than 1060 mm, 28.6% were in the 1180–1200 mm size-class. Therefore, we decided that the 11 year-old age-class was the oldest one that should be included in our analyses.

A similar approach was applied to king threadfin, whose minimum legal size is 350 mm TL on the east coast of Queensland.

Migration of king threadfin

Our current analyses assume that migration king threadfin between estuaries is low. Individual king threadfin can move large distances along the coastline (e.g. 550 km Kailola *et al.* 1993), potentially confounding relationships between freshwater flow and the abundance of king threadfin. However, the frequency of these movements and proportion of the population that moves such large distances is unknown. We evaluated tag-recapture data from the Suntag Program of the Australian National Sport Fishing Association Queensland Inc. (ANSQ Qld) for evidence of migration of king threadfin. In the Fitzroy River region, 148 king threadfin were tagged and recaptured between 1986 and 2005, being at-liberty for between 0 and 2599 days (median = 227 days), at sizes between 340 and 1424 mm FL. Although individuals had moved within the Fitzroy River estuary and adjacent surrounds, none had been recapture more than 68 km from their release location supporting our assumption that that migration rates between estuaries were low for king threadfin in the Fitzroy River region.

Our method also assumes that the bands on the otoliths of king threadfin from the Fitzroy River estuary are indicative of annuli. We could not find any published aging studies on king threadfin, nor any known age individuals. However, otoliths of king threadfin sampled from the Fitzroy River estuary had clearly defined opaque and translucent bands (Fig. 4). Over the five years of sampling, we observed consistent differences in the marginal increment of king threadfin otoliths collected in October to those collected in following February. Therefore, we assumed that like barramundi (see Staunton-Smith *et al.* 2004), otolith increments of king threadfin in the Fitzroy River estuary were laid annually and that the first increment could be accurately identified. The Fitzroy River estuary is towards the southern limit of the distribution of king threadfin in Australia, and water temperatures (and food availability) drop considerably over winter. The assumption of annuli may not be valid throughout the distribution of king threadfin, but appears to be reasonable for the Fitzroy River estuary, until otolith annuli can be validated in known age fish.

Appendix for Chapter 7. Assumptions of barramundi growth rates

Only the short-term effects of freshwater flow on growth rates were investigated, after accounting for length-at-release, seasonality of growth rates, and time-at-liberty. Possible lag effects of freshwater flows on growth rates were not investigated i.e. flow conditions that occurred in the river prior to the tagging and release of an individual were not considered. It is possible that pre-existing conditions affected the observed growth rates. Other sources of variability that are likely to affect growth rates, such as individual genetic variation, were also not investigated. Whilst the data included information on habitat type at release and recapture, there was no information on whether these habitats were consistent throughout the time-at-liberty. However, as only fish at liberty for between 30 and 366 days were used, unquantified habitat effects are likely to be small.

The ANSA Qld tag-recapture data are collected mostly from recreational and commercial fishers. There is potential for error in measurement of the total length of a fish and subsequent error in calculated growth rates. However, tagging and measurement of fish has been ongoing in the Fitzroy River region for over 20 years, and ANSA Qld has numerous members in this region that have many years of experience tagging and measuring fish. In addition, where possible, data (e.g. changes in total length) and estimated parameters (e.g. L_∞, C, t_s and K) were compared for similarity with that reported in the literature.

Appendix for Chapter 9. Banana prawn data

Table A.9.1 Estimated annual index of banana prawn abundance in the Fitzroy River estuary using fortnightly and monthly data, as well as different factors in the GLM model

Data included in GLM analysis	Periodicity	GLM model and predicted means for annual index	Estimated means for calculating annual index	Annual index of banana prawn abundance[1]	s.e. of annual index[1]
All trips	Fortnightly	Trip	Trip	158.019	8.6720
New moon v1	Monthly	Trip	Trip	176.986	14.4644
New moon v2	Monthly	Trip	Trip	203.312	12.7372
Full moon v1	Monthly	Trip	Trip	132.115	13.3337
Full moon v2	Monthly	Trip	Trip	126.421	13.2404
All trips	Fortnightly	Trip, Region, Trip*Region	Trip	155.524	8.1207
New moon v1	Monthly	Trip, Region, Trip*Region	Trip	183.157	16.2440
New moon v2	Monthly	Trip, Region, Trip*Region	Trip	198.990	12.8707
Full moon v1	Monthly	Trip, Region, Trip*Region	Trip	127.955	11.4668
Full moon v1	Monthly	Trip, Region, Trip*Region	Trip	131.930	12.9547
Full moon v2	Monthly	Trip, Region	Trip	126.505	12.6576
Full moon v2	Monthly	Trip, Region	Trip	127.201	11.3618
All trips	Fortnightly	Trip, Region, Trip*Region	Trip by region	624.648	32.5057
New moon v1	Monthly	Trip, Region, Trip*Region	Trip by region	734.880	59.9274
New moon v2	Monthly	Trip, Region, Trip*Region	Trip by region	809.514	47.9371
Full moon v1	Monthly	Trip, Region, Trip*Region	Trip by region	501.056	49.8390
Full moon v2	Monthly	Trip, Region, Trip*Region	Trip by region	504.878	49.4648

[1] The index and s.e. are based on the cumulative mean prawn abundance per trip x number of days between trips) across the sampling period.
New moon trips v1 = trips 1,6,8,10 and 12; new moon trips v2 = 2,6,8,10 and 12; full moon trips v1 = trips 3,7,9,11 and 13; full moon trips v2 = 4,7,9,11 and 13.

As expected, fortnightly sampling provided greater power to detect between year differences in annual mean prawn abundance than monthly sampling at all hypothetical levels of negative differences. The results of the power analysis suggest that if the level of variation in year-2 is similar to that in year-1 sampling, then it is likely we will have a >80% probability of detecting a between year difference in prawn abundance that is 40% less than the year-1 abundance (assuming a 95% significance level i.e., α level). Monthly sampling (at either of the full or new moon) would provide a much lower power (~50% probability) to detect a between year difference in prawn abundance that is 40% less than the year-1 abundance.

Table A.9.2 Dates, mean lengths, growth increments and growth rates for each pair of samples of banana prawns from the Fitzroy River derived from Figure 8.5 and underlying Figure 8.6

Sample year	Cohort	First date	Mean carapace length (mm)	Second date	Mean carapace length (mm)	Growth increment (mm)	Time interval (days)	Growth rate (mm/week)	Total flow (ML)
Year-1	1.1	13/01/2002	5.53	28/01/2002	7.29	1.76	15	0.82	189,243
		28/01/2002	7.29	9/02/2002	7.96	0.67	12	0.39	17,316
		09/02/2002	7.96	23/02/2002	8.78	0.82	14	0.41	49,193
		23/02/2002	8.78	10/03/2002	9.29	0.51	15	0.24	36,130
		10/03/2002	9.29	24/03/2002	10.35	1.06	14	0.53	9,181
		24/03/2002	10.35	9/04/2002	11.59	1.24	16	0.54	997
		09/04/2002	11.59	23/04/2002	13.58	1.99	14	1.00	2,615
		23/04/2002	13.58	8/05/2002	15.13	1.55	15	0.72	315
	1.2	08/05/2002	9.98	22/05/2002	11.02	1.04	14	0.52	252.
Year-2	2.1	02/11/2002	3.19	16/11/2002	7.00	3.81	14	1.91	0
		16/11/2002	7.00	2/12/2002	9.57	2.57	16	1.12	0
		02/12/2002	9.57	17/12/2002	11.85	2.28	15	1.06	0
	2.2	17/01/2003	4.23	31/01/2003	5.52	1.29	14	0.65	0
		31/01/2003	5.52	15/02/2003	8.34	2.82	15	1.32	1,580,532
		15/02/2003	8.34	28/02/2003	11.05	2.71	13	1.46	123,798
	2.3	16/03/2003	4.51	31/03/2003	6.95	2.44	15	1.14	20,490
		31/03/2003	6.95	15/04/2003	8.64	1.69	15	0.79	11,7600
		15/04/2003	8.64	30/04/2003	9.58	0.94	15	0.44	6,2840
		30/04/2003	9.58	14/05/2003	11.00	1.42	14	0.71	4,101
		14/05/2003	11.00	29/05/2003	12.3	1.3	15	0.61	335
	2.4	30/04/2003	4.44	29/05/2003	7.37	2.93	29	0.71	4,436
Year-3	3.1	24/10/2003	6.76	23/11/2003	8.01	1.25	30	0.29	306
	3.2	21/12/2003	5.43	20/01/2004	8.09	2.66	30	0.62	101,970
		20/01/2004	8.09	18/02/2004	10.94	2.85	29	0.69	766,373
	3.3	18/02/2004	5.15	19/03/2004	8.10	2.95	30	0.69	111,6420
		19/03/2004	8.10	17/04/2004	10.67	2.57	29	0.62	11,095
		17/04/2004	10.67	17/05/2004	12.64	1.97	30	0.46	540
Year-4	4.1	10/11/2004	9.60	11/12/2004	11.30	1.70	31	0.38	27,001
	4.2	8/01/2005	8.74	7/02/2005	10.87	2.13	30	0.50	443,384
		07/02/2005	10.87	10/03/2005	12.64	1.77	31	0.40	70425
	4.3	07/04/2005	9.97	6/05/2005	12.83	2.86	29	0.69	522

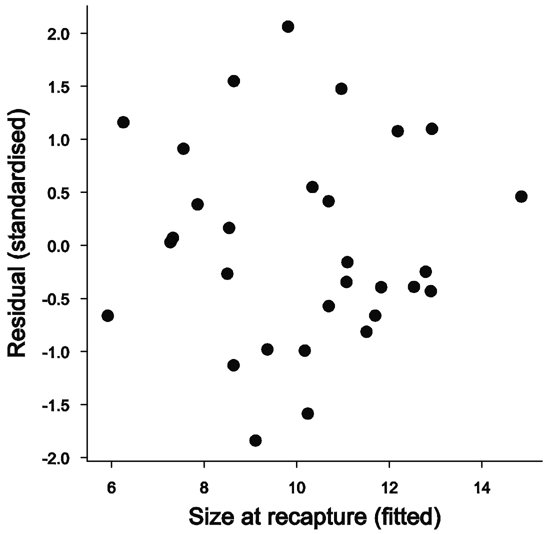
Table A.9.3 Dates, mean lengths, growth increments and growth rates for each pair of samples of banana prawns from the Calliope River underlying Figure 9.7

Sample year	Cohort	First date	Mean carapace length (mm)	Second date	Mean carapace length (mm)	Growth increment (mm)	Time interval (days)	Growth rate (mm/week)	Total flow (ML)
Year-2	2.1	04/12/2002	9.56	16/12/2002	12.57	3.01	12	1.76	0
	2.2	19/01/2003	9.01	2/02/2003	10.17	1.16	14	0.58	0
		02/02/2003	10.17	15/02/2003	12.09	1.92	13	1.03	262,921
	2.3	18/03/2003	7.54	2/04/2003	9.91	2.37	15	1.11	417
		02/04/2003	9.91	17/04/2003	11.31	1.40	15	0.65	301
		17/04/2003	11.31	2/05/2003	12.62	1.31	15	0.61	227
		16/05/2003	10.75	31/05/2003	12.99	2.24	15	1.05	190
Year-3	3.1	26/10/2003	4.28	25/11/2003	6.51	2.23	30	0.52	786
		22/01/2004	8.41	20/02/2004	10.14	1.73	29	0.42	49,342
		20/02/2004	10.14	21/03/2004	11.99	1.85	30	0.43	5,202
		21/03/2004	11.99	19/05/2004	16.58	4.59	59	0.54	632

Table A.9.4 Dates, mean lengths, growth increments and growth rates for each pair of samples of banana prawns from the Boyne River estuary underlying from Figure 9.8.

Sample year	Cohort	First date	Mean carapace length (mm)	Second date	Mean carapace length (mm)	Growth increment (mm)	Time interval (days)	Growth rate (mm/week)	Mean daily rainfall (mm)
Year-2	2.1	19/12/2002	11.92	6/01/2003	13.44	1.52	18	0.59	5.18
	2.2	30/01/2003	10	17/02/2003	13.13	3.13	18	1.22	27.19
		17/02/2003	13.13	27/02/2003	14.74	1.61	10	1.13	10.94
	2.3	15/03/2003	5.64	30/03/2003	7.14	1.5	15	0.70	1.37
		30/03/2003	7.14	14/04/2003	8.49	1.35	15	0.63	1.15
		14/04/2003	8.49	29/04/2003	10.13	1.64	15	0.77	0.71
	2.4	13/05/2003	7.52	28/05/2003	9.49	1.97	15	0.92	0.23
Year-3	3.1	22/11/2003	5.66	20/12/2003	11.13	5.47	28	1.37	6.30
	3.2	19/01/2004	8.07	17/02/2004	12.59	4.52	29	1.09	5.61
	3.3	18/03/2004	9.09	16/04/2004	11.56	2.47	29	0.60	0.82
		16/04/2004	11.56	16/05/2004	13.83	2.27	30	0.53	1.22

Figure A.9.1 Size at recapture and residual variance of banana prawn cohorts for Fitzroy River estuary data



Appendix for Chapter 10. Species lists of demersal communities

Table A.10.1 List of species caught by beam-trawl in the Fitzroy River estuary, with overall mean numbers per sample, and frequency of capture (i.e. percentage of trawls which caught at least one individual), ranked by species.

Species	Mean number per sample	Frequency of capture	Species	Mean number per sample	Frequency of capture	Species	Mean number per sample	Frequency of capture
Acetes spp.	1249.97	77.88%	*Latreutes cf pymoeus*	0.05	2.76%	*Megalops cyprinoides*	0.00	0.46%
Metapenaeus spp.	11.76	71.43%	*Leiognathus equulus*	0.05	2.61%	*Oratosquillina* sp. 1	0.00	0.46%
Penaeus merguiensis	27.04	69.59%	*Acanthopagrus berda*	0.04	2.61%	*Saurida tumbil*	0.00	0.46%
Thryssa hamiltoni	3.54	36.56%	Gobiidae sp. 2	0.04	2.61%	*Craterocephalus stercusmuscarum*	0.02	0.31%
Parapenaeopsis sculptilis	16.95	36.25%	Platycephalidae sp.	0.03	2.61%	*Drombus cf ocyurus*	0.01	0.31%
Johnius (Johnius) australis	4.45	33.18%	*Gerres subfasciatus*	0.09	2.46%	Unidentified gudgeon 2	0.01	0.31%
Prionobutis microps	3.59	29.34%	*Polydactylus macrochir*	0.04	2.46%	*Acentrogobius caninus*	0.00	0.31%
Pomadasys kaakan	1.16	29.19%	*Charybdis anisodon*	0.04	2.46%	*Pseudogobius* sp.	0.00	0.31%
Macrobrachium sp.	2.12	25.96%	*Pseudorhombus arsius*	0.04	2.00%	*Scomberoides* sp.	0.00	0.31%
Eleutheronema tetradactylum	0.79	23.50%	*Glossamia aprion*	0.04	1.84%	*Dexillichthys muelleri*	0.00	0.31%
Leiognathus decorus	1.36	20.43%	*Redigobius* sp. 2	0.03	1.84%	*Gobiopterus macrostoma*	0.00	0.31%
Thryssa setirostris	0.78	18.59%	*Platycephalus indicus*	0.02	1.84%	Larval fish 9	0.00	0.31%
Leandrites celebensis	2.14	18.28%	*Ambassis agassizii*	0.03	1.69%	*Monacanthus chinensis*	0.00	0.31%
Brachyamblyopus coecus	0.64	16.44%	*Paradicula setifer*	0.02	1.69%	*Muraenosox bagio*	0.00	0.31%
Stolephorus commersonii	0.80	16.28%	*Drombus* sp.	0.03	1.54%	*Amoya* sp.	0.00	0.15%
Aseraggodes rautheri	0.72	14.44%	Larval fish 1	0.02	1.54%	Carid sp. 4	0.00	0.15%
Periclimenes sp.	3.72	14.13%	*Paraplagusia sinerama*	0.02	1.54%	Larval fish 6	0.00	0.15%
Atypopenaeus formosus	0.86	13.21%	*Arenigobius frenatus*	0.02	1.54%	*Terapon* sp.	0.00	0.15%
Ambassis gymnocephalus	1.08	12.60%	Unidentified fish 3	0.06	1.38%	Blennidae sp.	0.00	0.15%
Marilyna pleurosticta	0.26	12.44%	*Callianassa australiensis*	0.03	1.38%	Carid sp. 1	0.00	0.15%
Loliolus noctiluca	0.25	12.14%	*Redigobius bikolanus*	0.03	1.23%	*Caridina longirostris*	0.00	0.15%
Valamugil sp.	0.42	11.98%	*Pelates quadrililineatus*	0.02	1.23%	*Caridina nilotica*	0.00	0.15%
Cynoglossus sp. 2	0.45	11.52%	*Enigmaplax littoralis*	0.02	1.23%	*Ctenotrypauchen microcephalus*	0.00	0.15%
Sillago spp.	0.26	11.52%	*Lutjanus russelli*	0.01	1.23%	*Drepane punctata*	0.00	0.15%
Nematalosa erebi	1.63	10.75%	*Cynoglossus* sp. 1	0.04	1.08%	*Epinephelus coioides*	0.00	0.15%
Escualosa thoracata	0.28	10.29%	*Philocheras cf angustirostris*	0.04	1.08%	Gobiidae sp. 1	0.00	0.15%
Selenotoca multifasciata	0.47	9.68%	*Polydactylus multiradiatus*	0.01	1.08%	*Hyporhamphus quoyi*	0.00	0.15%
Thryssa sp.	0.47	9.68%	Carid sp. 2	0.03	0.92%	*Hypseleotris sp*	0.00	0.15%
Favonigobius exquisitus	0.38	8.91%	*Aseraggodes* sp.	0.02	0.92%	*Latreutes mucronatus*	0.00	0.15%
Herklotsichthys castelnaui	0.18	7.68%	*Macropthalmus latreillei*	0.01	0.92%	*Leptobrama muelleri*	0.00	0.15%
Philypnodon grandiceps	2.83	7.07%	*Pantolabus radiatus*	0.01	0.92%	*Monodactylus argenteus*	0.00	0.15%
Hypseleotris compressa	0.66	6.91%	Palaemon sp.	0.06	0.77%	*Mugilogobius* sp.	0.00	0.15%
Alpheus sp. 1	0.10	6.91%	*Harpadon transluscens*	0.01	0.77%	*Nematalosa come*	0.00	0.15%
Larval fish 4	3.56	6.45%	*Pelates* sp.	0.01	0.77%	*Oratosquillina interupta*	0.00	0.15%
Butis butis	0.26	6.45%	*Acanthopagrus australis*	0.01	0.77%	*Platycephalus fuscus*	0.00	0.15%
Palaemon serrifer	0.34	6.14%	*Lates calcarifer*	0.01	0.77%	*Portunus* sp.	0.00	0.15%
Hyporhamphus sp 1	0.10	5.84%	*Australoplax tridentata*	0.01	0.77%	*Scylla serrata*	0.00	0.15%
Chelonodon patoca	0.07	5.68%	*Liza subviridis*	0.01	0.77%	*Siganus guttatus*	0.00	0.15%
Ambassis vachelli	0.55	5.53%	*Metapenaeopsis palmensis*	0.01	0.61%	*Siganus* sp.	0.00	0.15%
Redigobius sp. 1	0.15	5.38%	*Craterocephalus mugiloides*	0.01	0.61%	*Suggrundus* sp.	0.00	0.15%
Glossogobius biocellatus	0.07	3.53%	*Macropthalmus* sp.	0.01	0.61%	*Torquigener pleurogramma*	0.00	0.15%
Pseudomugil signifer	0.39	3.38%	*Dorripe* sp.	0.01	0.61%	Unidentified fish 5	0.00	0.15%
Arius graeffei	0.13	3.23%	Gobiidae sp. 3	0.01	0.61%	Unidentified fish 6	0.00	0.15%
Portunus pelagicus	0.11	3.23%	*Sphyraena putnamae*	0.01	0.61%	Xanthidae sp.	0.00	0.15%
Alpheus sp. 2	0.05	3.23%	*Gerres oyena*	0.09	0.46%	*Metapenaeopsis novoguineae*	0.00	0.15%
Terapon theraps	0.42	3.07%	*Aliaporcellana* sp.	0.01	0.46%	*Trachypenaeus fulvus*	0.00	0.15%
Apocryptodon mandurensis	0.03	3.07%	*Urocaridella urocaridella*	0.01	0.46%			
Metapenaeus ensis	0.06	2.76%	*Callionymus russelli*	0.00	0.46%			

Table A.10.2 List of species caught by beam-trawl in the Calliope River estuary, with overall mean numbers per sample, and hit rate (i.e. percentage of trawls which caught at least one individual), ranked by species.

Species	Mean number per sample	Frequency of capture	Species	Mean number per sample	Frequency of capture	Species	Mean number per sample	Frequency of capture
Acetes spp.	127.95	74.90	*Penaeus esculentus*	0.05	3.64	*Redigobius* sp. 2	0.01	1.21
Thryssa hamiltoni	7.84	63.56	*Enigmaplax littoralis*	0.05	3.24	*Sphyraena* sp.	0.01	1.21
Penaeus merguiensis	23.80	63.16	*Latreutes mucronatus*	0.13	3.24	*Strongylura* sp.	0.01	1.21
Leiognathus decorus	5.68	52.63	*Oratosquillina* sp. 1	0.11	3.24	*Parapenaeopsis sculptilis*	0.01	1.21
Metapenaeus sp.	4.72	52.23	*Pseudomugil signifer*	0.11	3.24	*Penaeus plebejus*	0.01	1.21
Sillago spp.	3.23	51.42	*Thryssa setirostris*	0.07	3.24	*Ambassis agassizii*	0.00	0.81
Stolephorus commersonii	6.09	43.32	*Acanthopagrus australis*	0.03	2.83	*Ambassis urotaenia*	0.00	0.81
Favonigobius exquisitus	1.03	32.79	*Butis butis*	0.02	2.83	*Apogon fasciatus*	0.00	0.81
Ambassis gymnocephalus	20.17	31.58	*Drombus* sp.	0.03	2.83	*Apogon nigripinnis*	0.00	0.81
Loliolus noctiluca	0.66	30.36	Gobiidae sp. 3	0.04	2.83	*Aseraggodes* sp.	0.00	0.81
Pomadasys kaakan	0.64	28.34	*Nematalosa erebi*	0.29	2.83	Carid sp. 1	0.00	0.81
Leandrites celebensis	1.73	24.70	*Redigobius sp. 1*	0.04	2.83	Carid sp. 3	0.00	0.81
Herklotsichthys castelnaui	3.46	21.46	*Siganus sp.*	0.04	2.83	Carid sp. 4	0.00	0.81
Marilyna pleurosticta	0.50	19.43	*Metapenaeopsis palmensis*	0.05	2.83	*Caridina longirostris*	0.00	0.81
Glossogobius biocellatus	0.33	18.22	*Arenigobius frenatus*	0.02	2.43	*Charybdis anisodon*	0.00	0.81
Ambassis vachelli	7.78	14.17	*Cynoglossus* sp. 2	0.02	2.43	*Cynoglossus* sp. 1	0.00	0.81
Callionymus russelli	0.21	14.17	*Leiognathus equulus*	0.05	2.43	*Dexillichthys muelleri*	0.00	0.81
Periclimenes sp.	1.11	14.17	*Monacanthus chinensis*	0.02	2.43	*Drepane punctata*	0.00	0.81
Hyporhamphus sp. 1	0.18	12.96	*Sepia* sp.	0.02	2.43	*Eleutheronema tetradactylum*	0.00	0.81
Drombus cf ocyurus	0.56	12.55	*Siganus guttatus*	0.04	2.43	Gobiidae sp. 2	0.00	0.81
Gerres subfasciatus	0.36	12.55	*Urocaridella urocaridella*	0.06	2.43	*Hyporhamphus* sp. 2	0.00	0.81
Valamugil sp.	0.71	12.55	*Aliaporcellana* sp.	0.02	2.02	*Hypseleotris compressa*	0.01	0.81
Acanthopagrus berda	0.22	10.93	*Amoya* sp.	0.03	2.02	*Lutjanus argentimaculatus*	0.00	0.81
Alpheus sp. 1	0.19	10.93	Larval fish 1	0.06	2.02	*Macropthalmus latreillei*	0.00	0.81
Alpheus sp. 2	0.34	10.53	*Oratosquillina* sp. 2	0.02	2.02	*Macropthalmus* sp.	0.00	0.81
Macrobrachium sp.	0.23	9.31	*Metapenaeopsis novoguineae*	0.02	2.02	*Oratosquillina interupta*	0.00	0.81
Selenotoca multifasciata	0.29	8.91	*Metapenaeus ensis*	0.02	2.02	*Palaemon* sp.	0.00	0.81
Latreutes cf pymoeus	0.30	8.50	*Brachyamblyopus coecus*	0.02	1.62	*Paradicula setifer*	0.00	0.81
Thryssa sp.	0.26	8.50	Carid sp. 2	0.02	1.62	*Pelates quadrililineatus*	0.00	0.81
Saurida tumbil	0.10	7.69	*Dorripe sp.*	0.02	1.62	*Pelates* sp.	0.00	0.81
Acentrogobius caninus	0.06	6.07	*Epinephelus coioides*	0.01	1.62	*Platycephalus arenarius*	0.00	0.81
Lutjanus russelli	0.07	6.07	*Liza subviridis*	0.02	1.62	*Platycephalus fuscus*	0.00	0.81
Portunus pelagicus	0.09	6.07	*Megalops cyprinoides*	0.02	1.62	*Pomadasys maculatum*	0.00	0.81
Chelonodon patoca	0.06	5.67	*Monodactylus argenteus*	0.01	1.62	Scomberoides sp.	0.02	0.81
Benthopanope estuarius	0.10	5.26	Platycephalidae sp.	0.01	1.62	*Siganus fuscesens*	0.01	0.81
Escualosa thoracata	0.23	5.26	*Portunus* sp.	0.01	1.62	*Suggrundus* sp.	0.00	0.81
Prionobutis microps	0.06	5.26	*Sphyraena putnamae*	0.01	1.62	*Torquigener pleurogramma*	0.00	0.81
Terapon theraps	0.15	5.26	*Callianassa australiensis*	0.01	1.21	Unidentified fish 4	0.00	0.81
Tripodichthys angustifrons	0.06	4.86	*Euprymna sp*	0.01	1.21	Xanthidae sp.	0.01	0.81
Apocryptodon mandurensis	0.05	4.45	*Gerres oyena*	0.01	1.21	*Atypopenaeus formosus*	0.00	0.81
Palaemon serrifer	0.17	4.05	*Hyporhamphus quoyi*	0.01	1.21	*Penaeus monodon*	0.00	0.81
Philocheras cf angustirostris	0.06	4.05	*Johnius (Johnius) australis*	0.01	1.21	*Trachypenaeus fulvus*	0.00	0.81
Philypnodon grandiceps	0.20	4.05	*Mugilogobius* sp.	0.01	1.21	*Petroscirtes lupus*	0.00	0.40
Pseudorhombus arsius	0.05	4.05	*Polydactylus multiradiatus*	0.01	1.21			
Platycephalus indicus	0.04	3.64	*Redigobius bikolanus*	0.01	1.21			

Table A.10.3 List of species caught by beam-trawl in the Boyne River estuary, with overall mean numbers per sample, and hit rate (i.e. percentage of trawls which caught at least one individual), ranked by species.

Species	Mean number per sample	Frequency of capture	Species	Mean number per sample	Frequency of capture	Species	Mean number per sample	Frequency of capture
Acetes spp.	2191.61	89.32	*Siganus* sp.	0.27	5.13	Carid sp. 2	0.06	1.28
Penaeus merguiensis	111.26	79.49	*Acanthopagrus australis*	0.07	4.70	*Ctenotrypauchen microcephalus*	0.01	0.85
Leiognathus decorus	19.66	76.50	*Gerres oyena*	0.07	4.70	*Epinephelus coioides*	0.01	0.85
Metapenaeus sp.	16.59	75.21	*Prionobutis microps*	0.04	4.27	*Leiognathus moretoniensis*	0.01	0.85
Thryssa hamiltoni	19.58	70.94	*Palaemon serrifer*	0.07	4.27	*Platycephalidae sp*	0.01	0.85
Ambassis gymnocephalus	57.77	53.42	*Polydactylus multiradiatus*	0.09	4.27	*Penaeus plebejus*	0.01	0.85
Sillago sp.	4.02	47.86	*Escualosa thoracata*	0.05	3.85	*Centrogenys vaigiensis*	0.01	0.85
Favonigobius exquisitus	1.59	42.31	*Sphyraena putnamae*	0.03	3.42	*Glossamia aprion*	0.01	0.85
Loliolus noctiluca	1.30	41.88	*Metapenaeopsis novoguineae*	0.03	3.42	Unidentified fish 7	0.01	0.85
Pomadasys kaakan	1.60	35.04	*Strongylura strongylura*	0.04	3.42	*Liza melinoptera*	0.02	0.85
Hyporhamphus sp 1	1.43	33.33	*Lutjanus russelli*	0.03	2.99	*Craterocephalus mugiloides*	0.03	0.85
Stolephorus commersonii	3.04	33.33	*Platycephalus indicus*	0.03	2.99	*Hyporhamphus quoyi*	0.03	0.85
Valamugil sp.	15.31	30.77	*Urocaridella urocaridella*	0.05	2.99	*Drepane punctata*	0.00	0.48
Glossogobius biocellatus	0.60	28.21	*Parapenaeopsis sculptilis*	0.09	2.99	*Ambassis* sp.	0.00	0.43
Macrobrachium sp.	2.30	26.07	*Callianassa australiensis*	0.14	2.99	*Amoya* sp.	0.00	0.43
Callionymus russelli	0.65	25.64	*Drombus* sp.	0.03	2.56	*Apogon poecilopterus*	0.00	0.43
Periclimenes sp.	1.67	20.94	*Metapenaeus ensis*	0.03	2.56	*Aseraggodes* sp.	0.00	0.43
Herklotsichthys castelnaui	2.63	20.94	*Benthopanope estuarius*	0.03	2.56	Carid sp. 1	0.00	0.43
Marilyna pleurosticta	0.97	20.51	*Charybdis anisodon*	0.03	2.56	*Caridina longirostris*	0.00	0.43
Leandrites celebensis	2.35	20.51	*Monodactylus argenteus*	0.03	2.56	*Eleutheronema tetradactylum*	0.00	0.43
Pseudomugil signifer	7.78	20.51	Gobiidae sp. 2	0.03	2.56	Larval fish 1	0.00	0.43
Ambassis vachelli	21.03	20.09	*Portunus* sp.	0.03	2.56	Larval fish 6	0.00	0.43
Thryssa sp.	1.38	17.09	*Torquigener pleurogramma*	0.03	2.56	*Lates calcarifer*	0.00	0.43
Drombus cf ocyurus	0.32	15.38	*Monacanthus chinensis*	0.07	2.56	*Leucosia ocellata*	0.00	0.43
Acanthopagrus berda	0.36	13.68	*Siganus fuscesens*	0.13	2.56	*Macropthalmus latreillei*	0.00	0.43
Selenotoca multifasciata	0.19	11.54	*Liza subviridis*	0.64	2.56	*Mugilogobius* sp.	0.00	0.43
Gerres subfasciatus	0.36	11.54	*Dexillichthys muelleri*	0.02	2.14	*Nematalosa come*	0.00	0.43
Philocheras cf angustirostris	0.26	10.68	*Redigobius* sp. 2	0.02	2.14	*Palaemon* sp.	0.00	0.43
Alpheus sp. 1	0.23	10.26	*Dorripe* sp.	0.03	2.14	*Paradicula setifer*	0.00	0.43
Leiognathus equulus	0.65	10.26	*Macropthalmus* sp.	0.03	2.14	*Pelates* sp.	0.00	0.43
Portunus pelagicus	0.18	9.40	*Sillago burrus*	0.03	2.14	*Petroscirtes lupus*	0.00	0.43
Chelonodon patoca	0.15	8.97	*Enigmaplax littoralis*	0.05	2.14	*Platycephalus fuscus*	0.00	0.43
Apocryptodon mandurensis	0.18	8.55	*Terapon theraps*	0.09	2.14	*Pomadasys maculatum*	0.00	0.43
Brachyamblyopus coecus	0.28	8.55	*Latreutes mucronatus*	0.27	2.14	*Pseudogobius* sp.	0.00	0.43
Alpheus sp. 2	0.12	8.12	*Oratosquillina* sp. 2	0.02	1.71	*Strongylura* sp.	0.00	0.43
Saurida tumbil	0.14	8.12	*Johnius (Johnius) australis*	0.02	1.71	*Suggrundus* sp.	0.00	0.43
Metapenaeopsis palmensis	0.21	8.12	*Lethrinus* sp. 1	0.02	1.71	*Synanceia horrida*	0.00	0.43
Nematalosa erebi	0.18	7.69	*Oratosquillina* sp. 1	0.02	1.71	*Tetractenos hamiltoni*	0.00	0.43
Philypnodon grandiceps	1.19	7.69	*Trachypenaeus fulvus*	0.02	1.71	Unidentified crab 1	0.00	0.43
Siganus guttatus	0.10	6.84	*Atypopenaeus formosus*	0.03	1.71	Unidentified crab 2	0.00	0.43
Pseudorhombus arsius	0.13	6.84	*Euprymna* sp.	0.03	1.71	*Metapenaeopsis* sp.	0.00	0.43
Redigobius sp. 1	0.13	6.84	Gobiidae sp. 3	0.04	1.71	*Alpheus* sp. 3	0.01	0.43
Thryssa setirostris	0.56	6.84	*Arenigobius frenatus*	0.01	1.28	Gobiidae sp. 1	0.01	0.43
Penaeus esculentus	0.34	6.41	*Sepia* sp.	0.01	1.28	Larval fish 4	0.01	0.43
Latreutes cf pymoeus	0.33	5.98	*Siphamia rosiegaster*	0.01	1.28	*Oratosquillina interupta*	0.01	0.43
Tripodichthys angustifrons	0.06	5.56	*Apogon fasciatus*	0.02	1.28	Scomberoides sp.	0.01	0.43
Butis butis	0.08	5.56	*Thalamita admete*	0.02	1.28	*Australoplax tridentata*	0.02	0.43
Cynoglossus sp. 2	0.07	5.13	*Pelates quadrililineatus*	0.03	1.28	Carid sp. 4	0.02	0.43
Acentrogobius caninus	0.13	5.13	*Redigobius bikolanus*	0.03	1.28			